**Virginia City Hybrid Energy Center**
**Response to Data Request**
**Bruce Buckheit, Member, Virginia Air Pollution Control Board**

**Question (Page No. 8):**

I believe there has been ample discussion of the qualitative health impacts from $PM_{2.5}$ emissions from the plant. However, there have been a number of studies by EPA and others that enable a general quantification of the health based economic impacts of $PM_{2.5}$ emissions. Using such generalized information, please prepare a spreadsheet that contains estimates of such costs associated with each of the options and assumed emission levels.

**Response:**

The studies that quantify economic impacts of $PM_{2.5}$ are based on the relationship between ambient air quality levels and health effects. Incremental changes in health effects related to air quality changes are assigned economic values. In order to assess the economic impacts of incremental changes in $PM_{2.5}$ levels associated with the alternative power generation technologies requires translating emissions to ambient air quality levels.

The Virginia City Hybrid Energy Center (VCHEC) is located in an area designated attainment for $PM_{2.5}$. Any power generation facility located at the VCHEC site would have to demonstrate compliance with the $PM_{2.5}$ ambient air quality standards to secure approval. Current guidance uses $PM_{10}$ as a surrogate for $PM_{2.5}$ (compliance with the $PM_{10}$ standards means compliance with the $PM_{2.5}$ standards). Dominion conducted air quality modeling approved by the Virginia DEQ and USEPA that demonstrates compliance with the $PM_{10}$ standards.

Dominion went beyond the current guidance and conducted a modeling study to assess VCHEC $PM_{2.5}$ ambient air quality impacts directly. The modeling study report was submitted as part of Dominion's response to comments and is included with this response (Attachment 1). The modeling study demonstrated compliance with the $PM_{2.5}$ standards, based on the conservative assumption that the combustion source $PM_{2.5}$ emission rate equals the $PM_{10}$ emission rate.

The modeling results show that the major contributors to the maximum predicted $PM_{2.5}$ impact are the material handling and fugitive dust sources. The particle size distributions for these sources include a $PM_{2.5}$ fraction. The low level release of this material results in near field maximum levels still below the NAAQS (Attachment 2). There are no people living in the area of maximum impact. Beyond 1,000 meters (0.6 miles) from plant fenceline, PM2.5 impacts are below 5.0 ug/m3 for the 24-hour average and 1.0 ug/m3 for the annual average. All of the coal based power generation technologies will have similar material handling systems and fugitive dust sources.

The alternative power generation technologies particulate emissions (filterable and condensable) limits are currently set for $PM_{10}$. Given the level of control required in recent permits and the types of control technologies used, much of the particulate emissions are $PM_{2.5}$. The $PM_{10}$ limits for the power generation technologies (PC, CFB, and IGCC) generally range from 0.01 lbs./MMBtu to 0.02 lbs./MMBtu (VCHEC $PM_{10}$ limit is 0.012 lbs./MMBtu). For comparison, combined cycle power generation facility $PM_{10}$ limits are generally on the order of 0.01 lbs./MMBtu.

Air quality unit emission impacts (ug/$m^3$ per g/sec) associated with PC and CFB power generation units are generally similar as their design stack heights and exhaust characteristics are similar. For example, the Greene Energy facility that is under construction in Nemacolin, PA has a 0.075 ug/m3 per g/sec unit emission factor for PM10 for a 24-hour averaging period[1]. The VCHEC CFB boilers have a 0.13 ug/m3 per g/sec unit emission factor for PM10 for a 24-hour averaging period.

The IGCC units designed with combustion turbines in a combined cycle configuration have lower stack heights, but higher exhaust flows than the PC/CFB units. The power generation technology combustion $PM_{2.5}$ emissions would likely have similar ambient air quality unit emission impacts. For comparison, a proposed combined cycle power plant in Rhode Island has a 0.20 ug/m3 per g/sec unit emission rate for a 325 MW unit[2].

For example, maximum predicted PM10 concentrations from the CFB boilers at the Greene Energy Project are 2.6 ug/m3 (24-hour) and 0.4 ug/m3 (annual average). PM2.5 concentrations would be slightly smaller. Maximum predicted PM10 concentrations from a proposed 325 MW combined cycle plant in Rhode Island are 1.6 ug/m3 (24-hour) and 0.1 ug/m3 (annual average).

Plots of predicted $PM_{2.5}$ levels (Attachment 2) for the VCHEC CFB boilers show concentrations generally below 3 ug/m3 for the 24-hour average and .5 ug/m3 for the annual average and decreasing with distance from the source. These ambient air quality levels are in the range of EPA's proposed SILs for PM2.5 of 1.2 – 5.0 ug/m3 and the variation in air levels between the alternative power generation technologies is generally less than the proposed SIls.

The other sources of $PM_{2.5}$ from the power generation technologies are the precursor emissions of $SO_2$ and $NO_X$. The precursor emissions vary to a greater degree than the primary $PM_{2.5}$ emissions. However, given the time and distance scales required for the atmospheric chemistry to occur, the variation in precursor generated $PM_{2.5}$ annual average ambient air quality levels between the power generation technologies are insignificant.

---

[1] Greene Energy Facility, 2004. Plan Approval Application. ENSR Document No. 102012-001-240. July, August (revisions).

[2] Rhode Island State Energy Center, 2008. As yet unpublished modeling results.

The variation in primary and precursor generated $PM_{2.5}$ air quality impacts resulting from the alternative power generation technologies will be relatively small and will affect ambient air quality levels below the standards set to protect the public health and environment with an adequate margin of safety. Accordingly, economic impacts associated with variations in $PM_{2.5}$ annual average ambient air quality levels are not a differentiating factor for the alternative power generation technologies.

# ATTACHMENT 1

# Attachment
# echnical Memo
# PM . Assessment or the Virginia City Hybrid Energy Center

Results of dispersion modeling of emissions from the proposed Virginia City Hybrid Energy Center (VCHEC) have been summarized in the Air Quality Permit Application, updated August, 2007. This memo provides an additional demonstration of compliance with the revised National Ambient Air Quality Standard (NAAQS) for particulate matter less than 2.5 m ($PM_{2.5}$).

The primary (and secondary) NAAQS for PM2.5 is 35 $g/m^3$ for the 24-hour average and is 15 $g/m^3$ for the annual average. The 24-hour NAAQS is met if the 8th percentile of 24-hour $PM_{2.5}$ concentrations in a year, averaged over three years, is less than or equal to 35 $g/m^3$. The annual NAAQS is met if the 3-year average of the annual average $PM_{2.5}$ concentration is less than or equal to 15 $g/m^3$.

Regional modeling conducted by the Virginia DEQ predicts that $PM_{2.5}$ concentrations in Southwest Virginia will decrease in time, taking into account industrial growth. Therefore this demonstration combines hourly modeled concentrations obtained for all primary and secondary particulates associated with proposed VCHEC sources, both controlled and fugitive, with hourly background $PM_{2.5}$ concentrations near the VCHEC produced by the Community Multiscale Air Quality (CMAQ) modeling system using future-year 200 emissions. Future-year emissions in the CMAQ modeling provides a basis for assessing NAAQS compliance when the VCHEC sources become active.

VCHEC PM Sources

Emissions from VCHEC sources are described in Volume 2 of the August, 2007 Air Quality Permit Application. For non-fugitive sources, $PM_{2.5}$ concentrations are taken to be equal to the $PM_{10}$ concentrations. This includes the impact of both primary emissions and secondary particulates, and is conservative in that mass due to particles larger than 2.5 m is not removed. For the fugitive sources, $PM_{2.5}$ was determined using the particulate distributions listed in Appendix B of Volume 2.

Modeled 200 Background $PM_{2.5}$

Output concentration data from the CMAQ modeling system were provided by the Virginia DEQ in the form of CMAQ ACONC files (surface layer) for the 12km fine-scale simulations. These are the 200 G1A simulations that use projected 200 emissions with 2002 meteorological data. Hourly $PM_{2.5}$ concentrations are obtained by summing Aitkin and Accumulation Mode particulates, excluding sea salt and water. Species summed include both primary and secondary particulates ASO4I, ANH4I, ANO3I, AORGAI, AORGPAI, AORGBI, AECI, A25I, ASOC1I, ASOC2I, ASOC3I, ASO4J, ANH4J, ANO3J, AORGAJ, AORGPAJ, AORGBJ, AECJ, A25J, ASOC1J, ASOC2J, and ASOC3J.

These hourly $PM_{2.5}$ concentrations are interpolated in space to each of the 3318 CALPUFF receptor locations, and shifted in time to the time zone of the CALPUFF simulations. They are written to a CALPUFF concentration file so that they can be readily added to the modeled hourly concentrations due to project sources.

Results

Total simulated $PM_{2.5}$ concentrations are obtained at each receptor by summing the hourly $PM_{2.5}$ concentrations from the 2002 VCHEC simulations with the hourly CMAQ future-year 200 $PM_{2.5}$ concentrations. Both of these simulations use 2002 meteorology so that their results are temporally aligned. Otherwise, these simulations could not be combined. Temporal alignment allows a consistent treatment of the transformation, transport, and dispersion of background emissions and VCHEC emissions

An annual concentration is obtained at each receptor using a simple average. The 24-hour average at each receptor is also obtained using a simple average, and the $8^{th}$ percentile concentration for the year at each receptor is the $8^{th}$-largest of these 24-hour averages. These results at each receptor are ranked, and the receptor with the largest $8^{th}$ percentile 24-hour average $PM_{2.5}$ concentration, and the receptor with the largest annual average $PM_{2.5}$ concentration are selected for comparison with the NAAQS.

Table 1 presents the result of this demonstration. The largest projected $8^{th}$ percentile 24-hour concentration for meteorological year 2002 is 26.73 $g/m^3$. The largest projected annual concentration for meteorological year 2002 is 13.04 $g/m^3$. Neither of these exceeds the $PM_{2.5}$ NAAQS.

**able . Predicted PM . Concentrations or Compliance ith NAAQ**

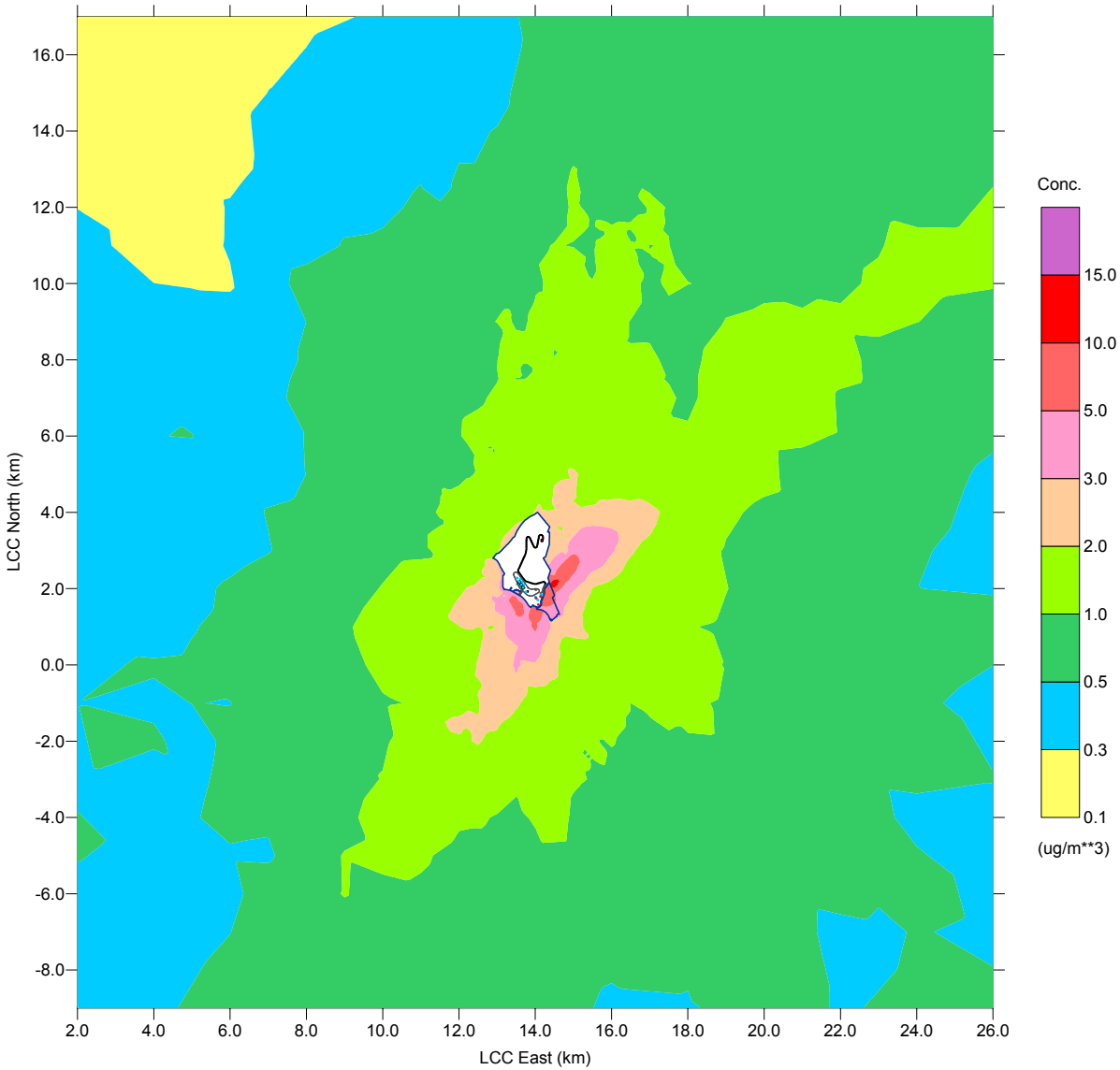
| Pollutant | A erage | Pro ect Contribution to Ma imum Conc. ( g m ) | Background Conc. ( g m ) | Receptor ocation | | Ending ime Period ( ear, Day, Hour) | otal Conc. ( g m ) | NAAQ ( g m ) |
|---|---|---|---|---|---|---|---|---|
| | | | | CC , (km) | M , (km) | | | |
| $PM_{2.5}$ | 24-Hour[1] | 14.47 | 12.26 | 14.5, 2.1 | 381.175, 4086.738 | 2002, 10, 24 | 26.73 | 35 |
| | Annual[2] | 4.72 | 8.32 | 14.5, 2.1 | 381.175, 4086.738 | 2002 | 13.04 | 15 |

1 Maximum 8th percentile (highest-eighth-high) value.
2 Maximum Rank 1 (high) value.
3 LCC Projection Origin 36. ° N, 82.5° W Matching Parallels 27.0° N, 50.0° N False Easting False Northing 0.0 Datum WGS-84.
4 UTM Projection Hemisphere Northern one 17 Datum NAD-83.

# ATTACHMENT 2

# Dominion 2002 PM2.5 24hr

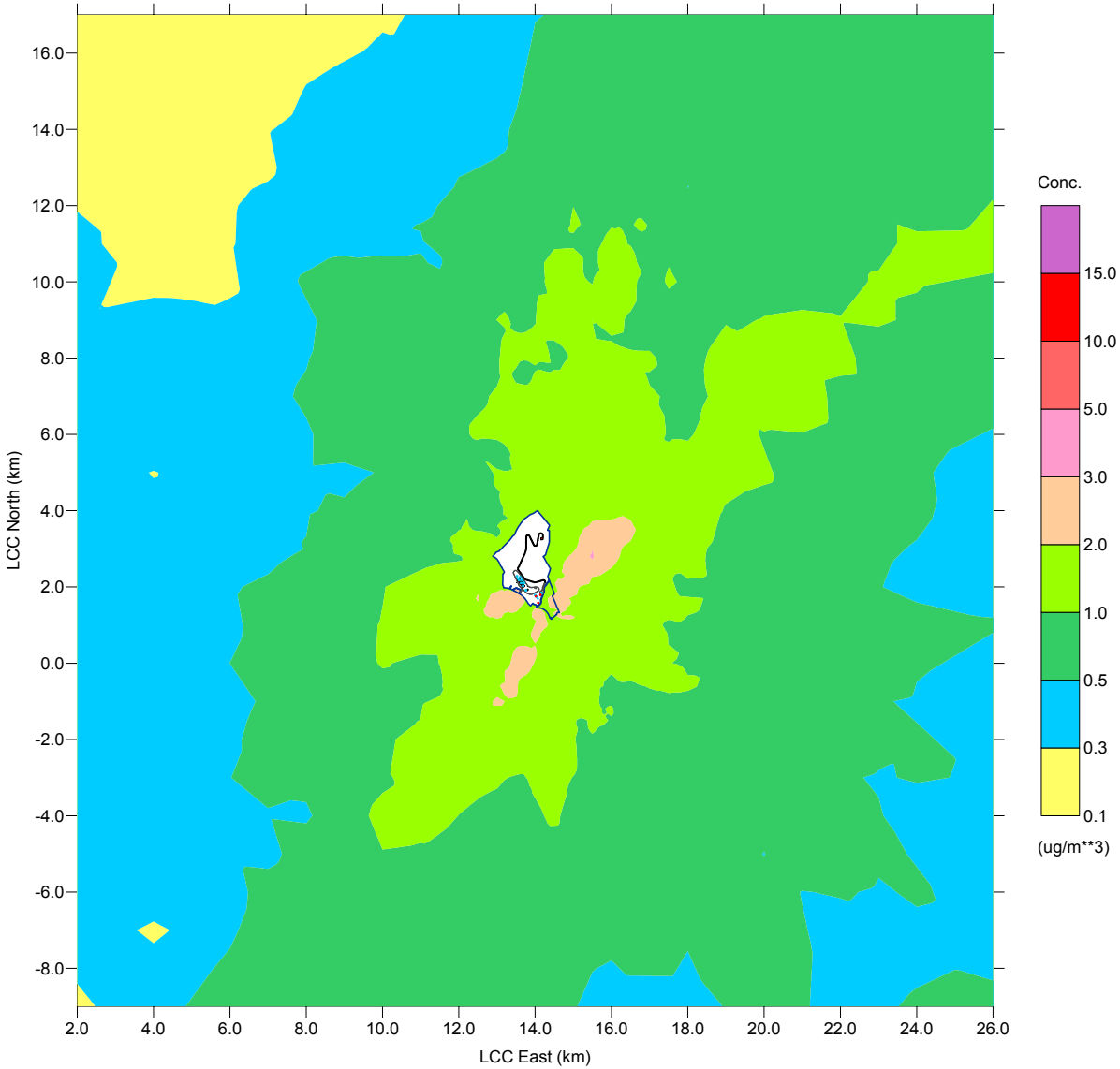
## H8H Concentration Contours for Facility Only (CFB Boiler - 100% Load)




LCC Origin: 36.9N, 82.5W
Matching Parallels: 27.0N, 50.0N
False Easting: 0.0
False Northing: 0.0
Datum: WGS-84

# Dominion 2002 PM2.5 24hr

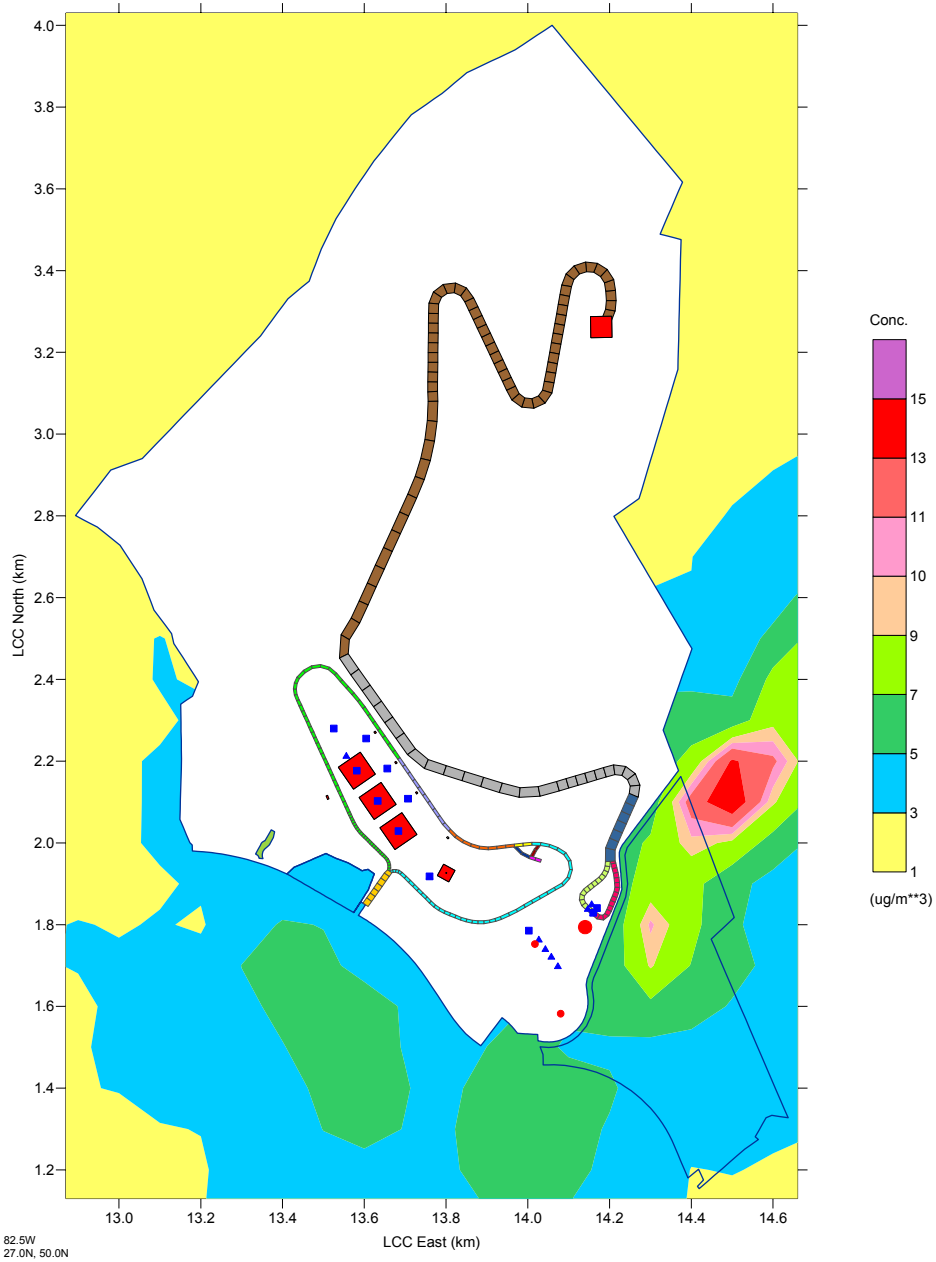
## H8H Concentration Contours for CFB Boiler - 100% Load Only




LCC Origin: 36.9N, 82.5W
Matching Parallels: 27.0N, 50.0N
False Easting: 0.0
False Northing: 0.0
Datum: WGS-84

# Dominion 2002 PM2.5 24hr

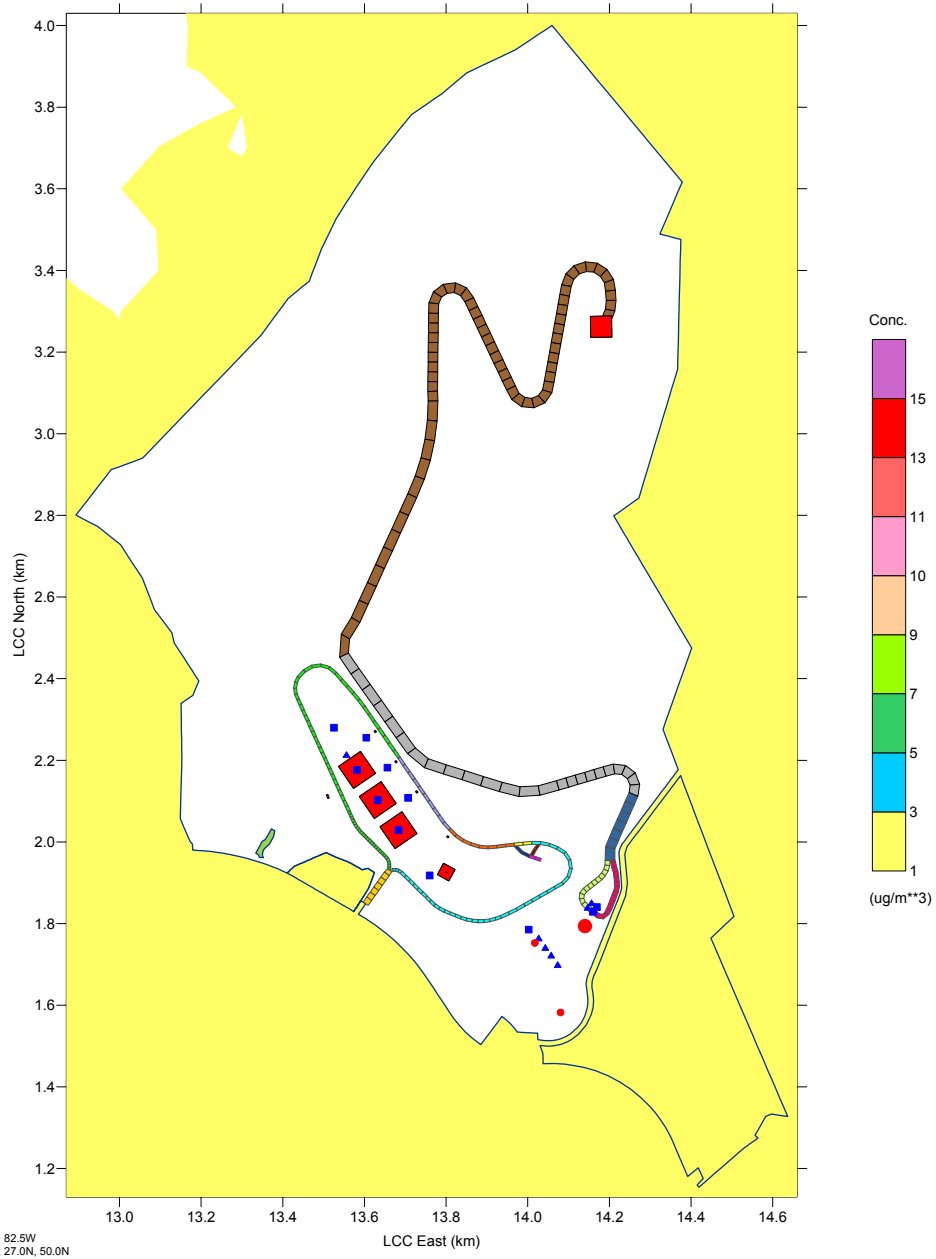
## H8H Concentration Contours for Facility Only (CFB Boiler - 100% Load)




LCC Origin: 36.9N, 82.5W
Matching Parallels: 27.0N, 50.0N
False Easting: 0.0
False Northing: 0.0
Datum: WGS-84

# Dominion 2002 PM2.5 24hr

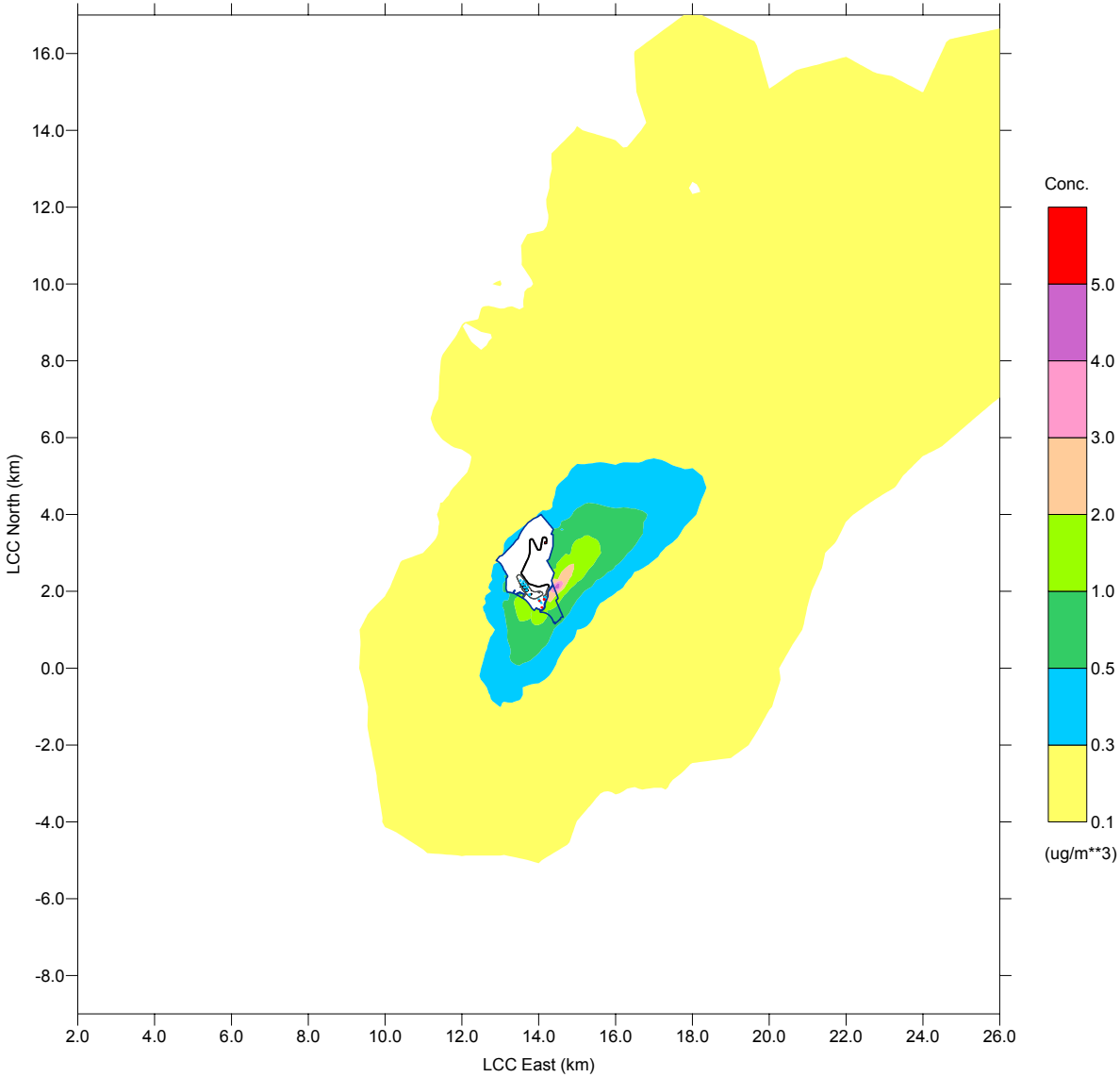
## H8H Concentration Contours for CFB Boiler - 100% Load Only




LCC Origin: 36.9N, 82.5W
Matching Parallels: 27.0N, 50.0N
False Easting: 0.0
False Northing: 0.0
Datum: WGS-84

# Dominion 2002 PM2.5 Annual

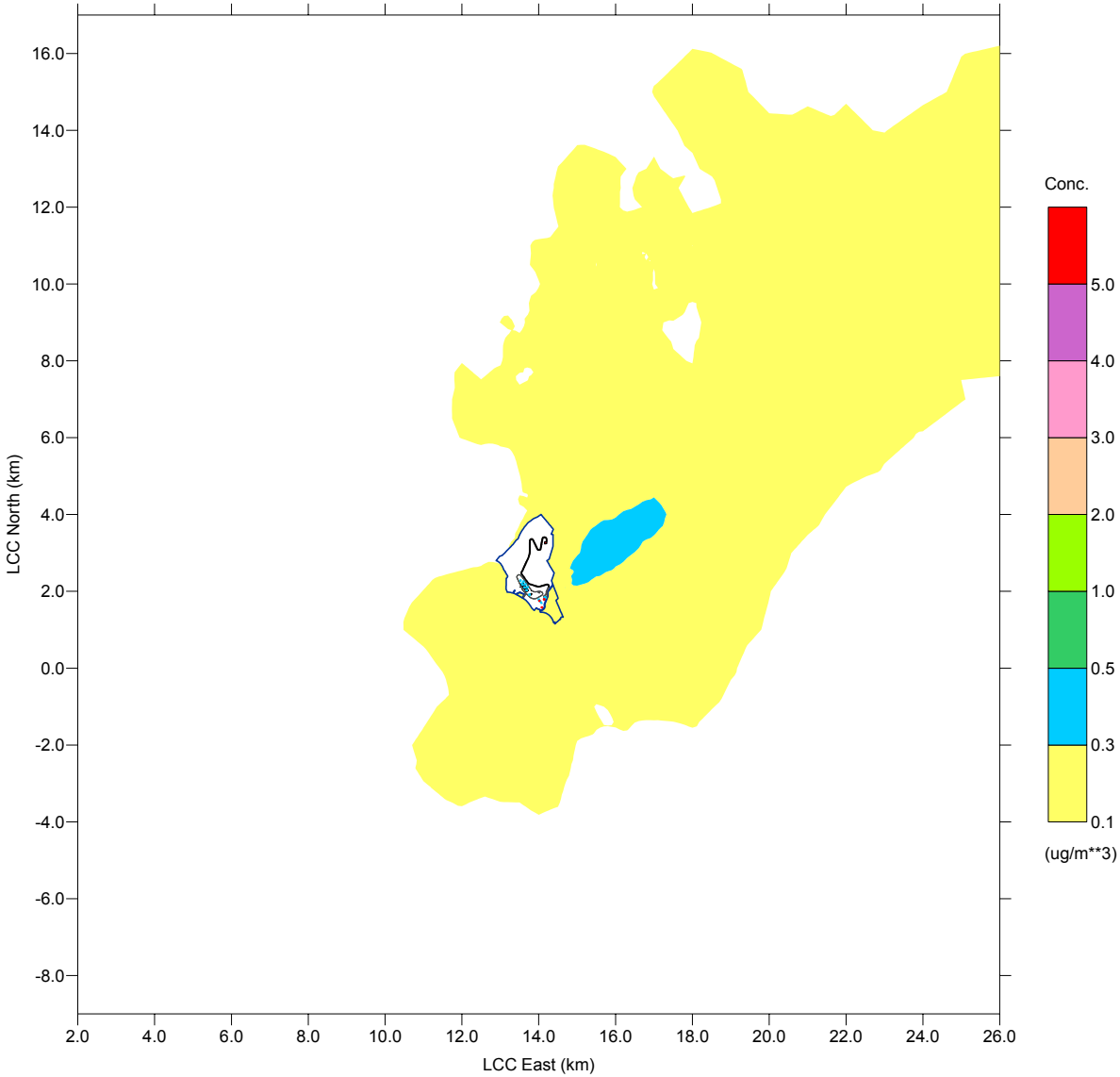
## Concentration Contours for Facility Only (CFB Boiler - 100% Load)




LCC Origin: 36.9N, 82.5W
Matching Parallels: 27.0N, 50.0N
False Easting: 0.0
False Northing: 0.0
Datum: WGS-84

# Dominion 2002 PM2.5 Annual

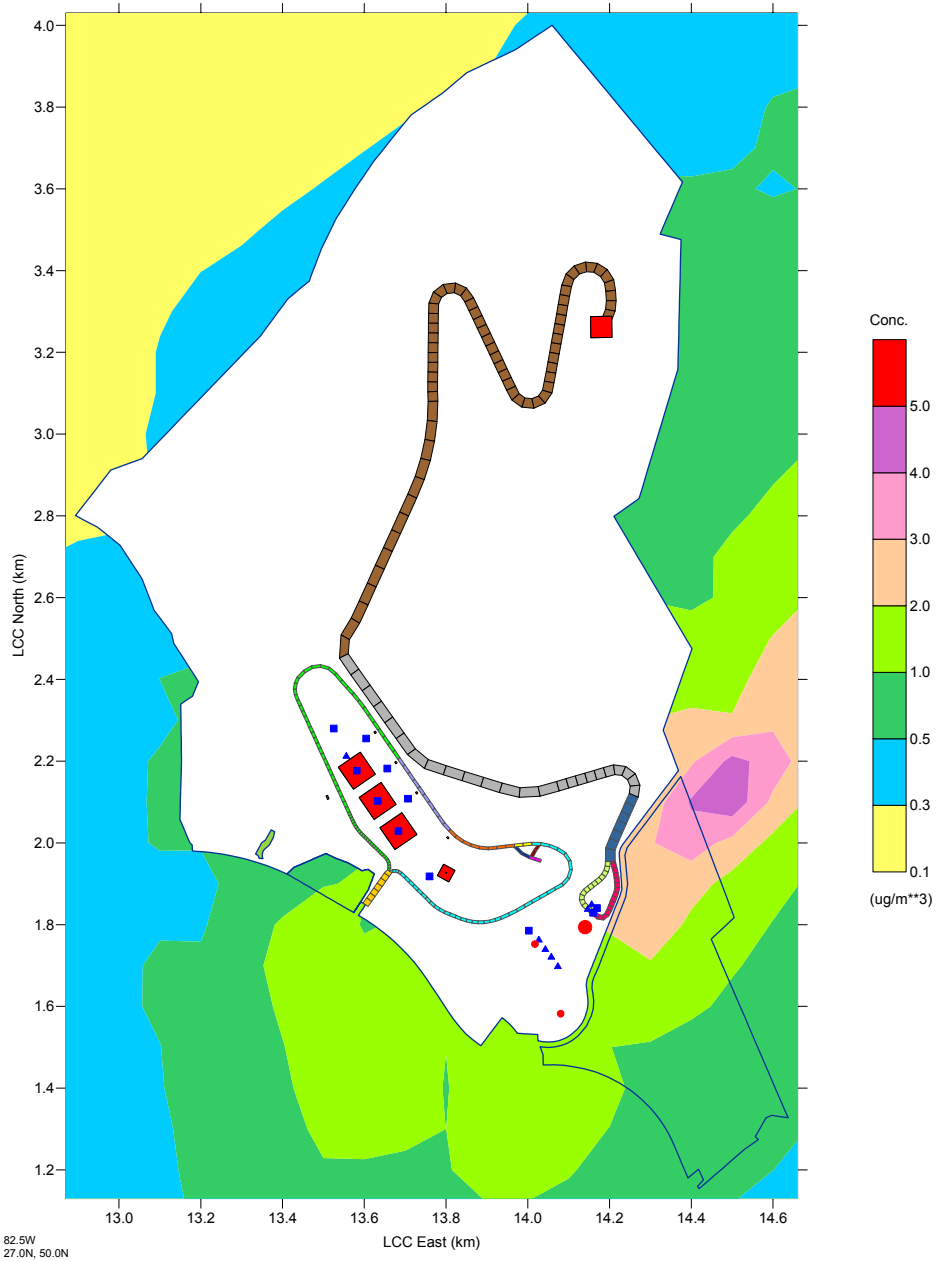
## Concentration Contours for CFB Boiler - 100% Load Only




LCC Origin: 36.9N, 82.5W
Matching Parallels: 27.0N, 50.0N
False Easting: 0.0
False Northing: 0.0
Datum: WGS-84

# Dominion 2002 PM2.5 Annual

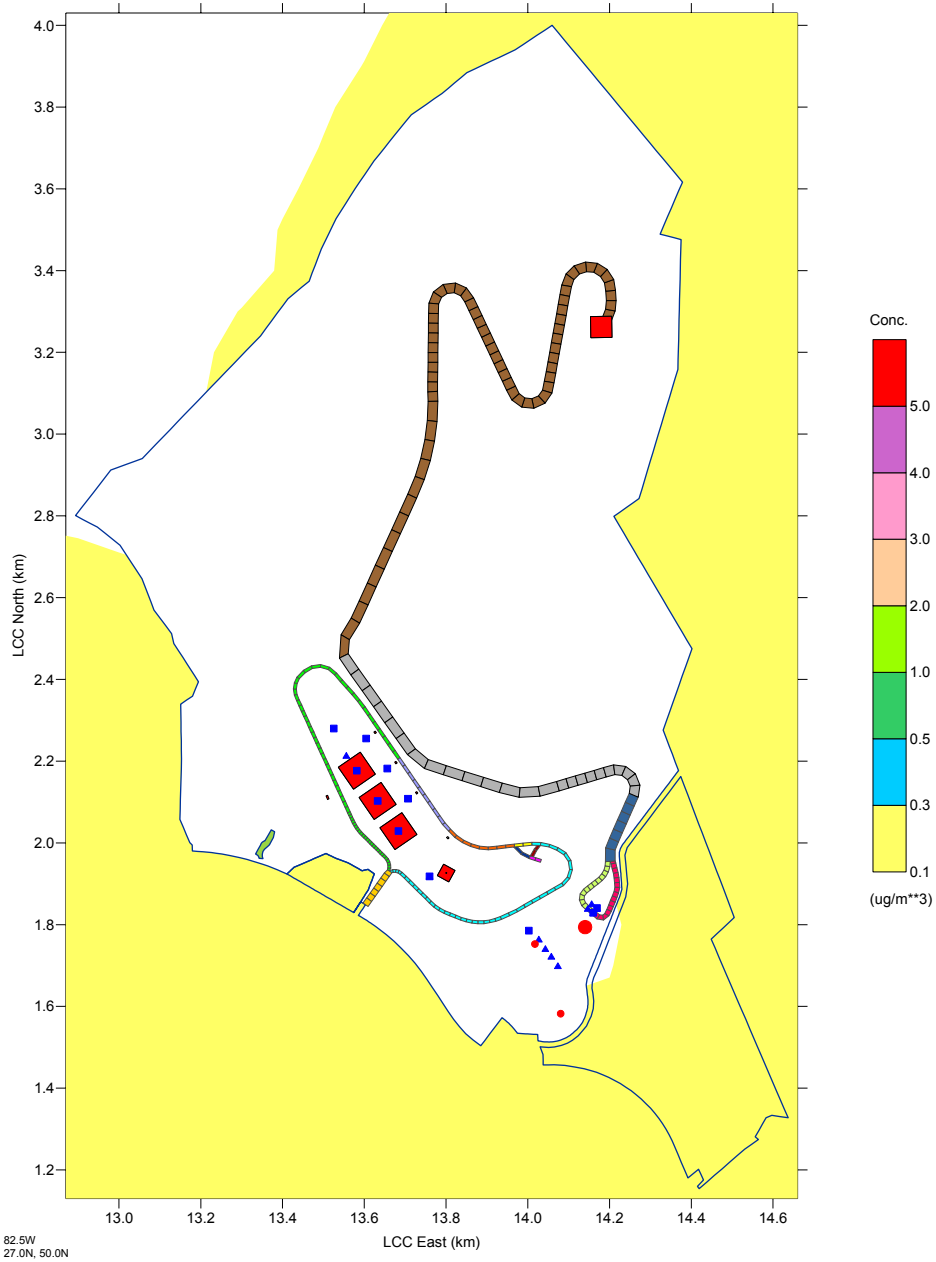
## Concentration Contours for Facility Only (CFB Boiler - 100% Load)




LCC Origin: 36.9N, 82.5W
Matching Parallels: 27.0N, 50.0N
False Easting: 0.0
False Northing: 0.0
Datum: WGS-84

# Dominion 2002 PM2.5 Annual

## Concentration Contours for CFB Boiler - 100% Load Only




LCC Origin: 36.9N, 82.5W
Matching Parallels: 27.0N, 50.0N
False Easting: 0.0
False Northing: 0.0
Datum: WGS-84